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EXAMINER	
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Please find below and/or attached an Office communication concerning this application or proceeding.

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

MAILED
JUN 9 2006
GROUP 2800

Application Number: 10/047,878
Filing Date: January 17, 2002
Appellant(s): ZHOU ET AL.

Shigian Zhou et al.
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 2/27/2006 appealing from the Office action mailed 3/14/2005.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is substantially correct. The changes are as follows:

Claims 1, 2 and 6 are rejected under 35 USC 102(b) instead of 102 (a).

Claims 3-5, 7-12 and 14-18 are rejected under 35 USC 103 (a) instead of 103

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,019,733	Kano et al.	5-1991
5,189,325	Jarczynski	2-1993
5,994,804	Grennan et al.	11-1999
JP 09-154258	Yamamoto	6-1997

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2 and 6 are rejected under 35 U.S.C. 102(b) as being anticipated by Kano et al.

Regarding claim 1, Kano et al. show an electric motor comprising: a stator (62 in Fig. 4) for producing a magnetic field; a rotor (74) rotated by said magnetic field; a motor shaft (22) coupled to said rotor; and a first set of passageways (96b in Fig. 4) through said rotor to conduct a nongaseous liquid coolant (engine oil), a passage (96a) in said motor shaft to conduct said nongaseous liquid coolant; and wherein said nongaseous liquid coolant is conducted through said rotor and said motor shaft by centrifugal force generated by the rotation of said electric motor (Col. 1, lines 40-58).

Regarding claim 2, Kano et al. also discloses an electric motor wherein said stator includes current-carrying coils (64) to generate said magnetic field.

Regarding claim 6, Kano et al. also discloses an electric motor wherein said first set of passageways has entrance openings and exit openings, said entrance openings oriented about said motor shaft center line at a first diameter, said exit openings oriented about said motor shaft center line at a second diameter, and said first diameter being less than said second diameter.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kano et al. in view of Jarczynski.

Regarding claim 3, Kano et al. shows all limitations of the claimed invention except showing the electric motor wherein the rotor is a squirrel cage rotor.

However, Jarczynski discloses the electric motor wherein the rotor is a squirrel cage rotor for the purpose of providing higher power density machinery motor (Col. 4, lines 1-5).

Since Kano et al. and Jarczynski are in the same field of endeavor, the purpose disclosed by Jarczynski would have been recognized in the pertinent art of Kano et al.

It would have been obvious at the time the invention was made to a person having an ordinary skill in the art to modify Kano et al. by forming a squirrel cage rotor for the motor as taught by Jarczynski for the purpose of improving the cooling of the motor.

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kano et al.

Regarding claims 4, Kano et al. disclose the invention except showing the rotor includes permanent magnet. It would have been obvious to one having ordinary skill in the art at the time the invention was made to make rotor with permanent magnet, since the Examiner takes Official Notice of the equivalence of permanent magnet and electromagnet for their use in the construction of an electric motor and the selection of any of these known equivalents would be within the level of ordinary skill in the Art.

Claims 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kano et al. in view of Yamamoto.

Regarding claim 5, Kano et al. shows all limitations of the claimed invention except showing the electric motor wherein the motor shaft includes an interior surface that is cone shaped to conduct a liquid coolant through said interior surface to cool the electric motor.

However, Yamamoto discloses the electric motor wherein said motor shaft includes an interior surface that is cone shaped to conduct a liquid coolant through said interior surface to cool the electric motor for the purpose of improving the cooling of the motor.

Since Kano et al. and Yamamoto are in the same field of endeavor, the purpose disclosed by Yamamoto would have been recognized in the pertinent art of Kano et al.

It would have been obvious at the time the invention was made to a person having an ordinary skill in the art to modify Kano et al. by using shaft includes an interior surface that is cone shaped to conduct a liquid coolant through said interior surface to cool the electric motor as taught by Yamamoto for the purpose of improving the cooling of the motor.

Claims 7,8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kano et al. in view of in view of Grennan et al.

Regarding claim 7, Kano et al. shows all limitations of the claimed invention except showing the electric motor further including a second set of passageways between said rotor and said motor shaft.

However, Grennan et al. disclose the electric motor further including a second set of passageways between said rotor (20 in Fig. 1) and said motor shaft (32 in Fig. 1 and Col. 4, lines 1-35) for the purpose of cooling off the motor.

Since Kano et al. and Greenan et al. are in the same field of endeavor, the purpose disclosed by Grennan et al. would have been recognized in the pertinent art of Kano et al.

It would have been obvious at the time the invention was made to a person having an ordinary skill in the art to modify Kano et al. by using a set of passageways between said rotor and said motor shaft as taught by Grennan et al. for the purpose of cooling off the motor.

Regarding claim 8, the structure disclosed Kano et al. modified by Grennan et al. would have second set of passageways have entrance openings and exit openings, said entrance openings oriented about said motor shaft center line at a first diameter, said exit openings oriented about said motor shaft center line at a second diameter, and said first diameter being less than said second diameter (because of the conical shape of the shaft).

Claims 9-12, 14, 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamamoto in view of Kano et al.

Regarding claim 9, Yamamoto also discloses an electric motor comprising: a wound stator (10 in Fig. 1), said wound stator conducting current to generate a magnetic field; a rotor (6) rotated by said magnetic field; a motor shaft (7) coupled to said rotor, said motor shaft including a cone-shaped interior surface having an entrance opening (4) and an exit opening (9a and 9b); and a liquid coolant propelled by centrifugal force generated by the rotation of said rotor through said cone-shaped interior surface, said liquid coolant cooling the electric motor (abstract). Yamamoto fails to show a first set of passageways through said rotor to conduct said liquid coolant through said rotor, said nongaseous liquid coolant propelled by centrifugal force through said first set of passageways

However, Kano et al. disclose a first set of passageways (96b in Fig. 4) through said rotor to conduct said liquid coolant (engine oil) through said rotor, said nongaseous liquid coolant propelled by centrifugal force (Col. 1, lines 40-57) through said first set of passageways for the purpose of cooling off the motor.

Since Yamamoto and Kano et al. are in the same field of endeavor, the purpose disclosed by Kano et al. would have been recognized in the pertinent art of Yamamoto.

It would have been obvious at the time the invention was made to a person having an ordinary skill in the art to modify Yamamoto by a first set of passageways through said rotor to conduct said liquid coolant through said rotor, said nongaseous liquid coolant propelled by centrifugal force through said first set of passageways as taught by Kano et al. for the purpose of cooling off the motor.

Regarding claim 10, Yamamoto also discloses an electric motor wherein said rotor is a squirrel cage rotor.

Regarding claim 11, Yamamoto also shows the rotor includes permanent magnets (Fig. 1)

Regarding claim 12, Yamamoto also discloses an electric motor wherein said liquid coolant is oil (abstract).

Regarding claim 14, Kano et al. also discloses an electric motor wherein said first set of passageways has entrance openings and exit openings, said entrance openings oriented about said motor shaft center line at a first diameter, said exit openings oriented about said motor shaft center line at a second diameter, and said first diameter being less than said second diameter.

Regarding claim 17, it is noted that all limitations of the claimed invention have been fulfilled by Yamamoto and Kano et al.

Regarding claim 18, Yamamoto also discloses an electric motor wherein said liquid coolant is oil (abstract).

Claims 15 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamamoto in view of Kano et al. and further in view Grennan et al.

Regarding claim 15, Yamamoto and Kano et al. show all limitations of the claimed invention except showing the electric motor further including a second set of passageways between said rotor and said motor shaft.

However, Grennan et al. disclose the electric motor further including a second set of passageways between said rotor (20 in Fig. 1) and said motor shaft (32 in Fig. 1 and Col. 4, lines 1-35) for the purpose of cooling off the motor.

Since Yamamoto, Kano et al. and Greenan et al. are in the same field of endeavor, the purpose disclosed by Grennan et al. would have been recognized in the pertinent art of Yamamoto and Kano et al.

It would have been obvious at the time the invention was made to a person having an ordinary skill in the art to modify Yamamoto and Kano et al. by using a set of passageways between said rotor and said motor shaft as taught by Grennan et al. for the purpose of cooling off the motor.

Regarding claim 16, the structure disclosed by Yamamoto and Kano et al, modified by Grennan et al. would have second set of passageways have entrance openings and exit openings, said entrance openings oriented about said motor shaft center line at a first diameter, said exit openings oriented about said motor shaft center line at a second diameter, and said first diameter being less than said second diameter (because of the conical shape of the shaft).

(10) Response to Argument

Regarding claims 1, 2 and 6, Appellant's argument is on the ground that "the present claimed invention utilizes a nongaseous liquid coolant propelled by centrilfugal force while the air described in Kano et al. in column 1, lines 53-56 is clearly a gas and not a nongaseous liquid and the lubricating oil chamber is connected with an engine oil supply source, such as a pump (column 3, lines 50-52). Therefore, Kano does not teach or suggest the present claimed invention". The Examiner respectfully disagrees with the Appellant. In one aspect of the present invention, the oil is used as the cooling medium (column 1, lines 40-50 and column 3, lines 50-53) with the use of the pump. However, due to the right angle of the cooling passage way 96b in the rotating rotor with respect to the shaft, it is inherent that the oil or nongaseous liquid coolant are conducted through the passage ways 96b and the rotor shaft by centrilfugal force generated by the rotation of the electric motor and there is no obstacle in the structure to prevent the centrilfugal force. Since **each and every limitation** of the claimed invention as recited in claims 1, 2 and 6 is disclosed in Kano's reference, the rejection under 35 USC 102 (b) is still deemed proper.

Regarding claim 4, the Appellant rejects Official Notice of the equivalence of permanent magnet and electromagnet for their use in the construction of an electric motor and the selection of any of these known equivalents would be within the level of ordinary skill in the Art. However, it is common knowledge in the Art of electric motor /generator to use permanent magnet instead of electromagnet. Evidence can be found in one reference cited by the Examiner, Yamamoto, discloses in paragraph (011) a

permanent magnet brushless motor with permanent magnet in the rotor. The Examiner also noticed that the use of permanent magnet in the rotor is not shown in the drawings of the present invention, if that feature is a unique feature discovered by the inventors, it should have been shown in the drawings.

Regarding claims 3, 9-12, 14, 17 and 18, Kano discloses a cooling structure for the motor using of centrifugal force to propel coolant through a rotor and motor shaft (inherent as shown in Fig. 4).

Regarding claims 15 and 16, In response to applicant's argument that "the combination of Grennan, Kano et al. and Yamamoto would generate a nonfunctioning system", the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). In the instant case, the teachings of Grennan to use a set of passage ways between the shaft and the rotor for the purpose of cooling off the motor would be easily recognized by an ordinary skill in the art.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Hanh Nguyen Nguyen

May 16, 2006

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PTO 01-[PTO 2006-4678] Japan Patent

(Number of Document H09-154258)

[COOLING MECHANISM OF A FORCIBLE OIL COOLING TYPE MOTOR OR GENERATOR]

Author (Niroh Nagamoto)

UNITED STATES PATENT AND TRADEMARK OFFICE

Washington, D.C. May 2006

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Country	:	Japan
Document No.	:	09-154258
Document Type	:	Patent application
Language	:	Japanese
Inventor	:	Shunei Yamamoto
Applicant	:	Mitsubishi Heavy Industry Corp.,
IPC	:	H02K 9/19; B61C 17/00
Application Date	:	November 29, 1995
Publication Date	:	June 10, 1997
Native Title	:	強制油冷式電動機又は発電機の冷却構造
English Title	:	Cooling mechanism of a forcible oil cooling type motor or generator

(54) Specification

1. [Title of the invention]

COOLING MECHANISM OF A FORCIBLE OIL COOLING TYPE MOTOR OR GENERATOR

(57) [Abstract]

[Topic]

The heat generated by a motor or the coil inside of a motor is efficiently and uniformly enabled to be removed from all over the entire coil surface which covers from the load shaft to the counter load shaft side.

[Solution means]

The cooling hollow hole inside of the rotor shaft
Of the motor or a generator was made in parallel with the traditional rotation shaft core, however, in the present invention, it is designed such that the cooling hydraulic feeding port has a small diameter, and the output shaft side has a large diameter, thus made to be a tapered hollow hole, hence, due to the centrifugal force which acts on the cooling oil, uniform amount of cooling oil flies to the coil from either one of small holes 9a, 9b, thus enabling the efficient coil cooling.

[Scope of the patent claims]

[Claim item 1]

Regarding the structure which forcefully cools hydraulically wherein the inside of rotor rotation shaft is made hollow, into which the cooling oil is force-fed from outside, said cooling oil

flies by the centrifugal force, this cooling mechanism of the forcible oil cooling type motor or generator is characterized such that the inside of rotor rotation shaft is made hollow, and tapered, and the output side of the motor and the drive side of the generator are made to be the large diameter side of the aforementioned tapered hole.

[Detailed explanation of the invention]

[0001]

[Utilized field in industry]

The present invention relates to the cooling oil path structure of rotor rotation shaft of a motor or a generator in which forcible oil cooling method used for electrically driven vehicles and the like is used for higher output.

[0002]

[Prior arts]

Regarding the traditional oil cooling type generator or a motor, as shown in figure 2, hollow hole 07 is made in rotor rotation shaft 012, and a plural number of small holes 09(09a, 09b) are opened on this rotor rotation shaft side surface, the small holes are used to feed the cooling oil. In this structure, cooling oil is force fed into the hollow hole 09, then, from the plural number of small holes 09, by the centrifugal force accompanied by the rotation of rotor rotation shaft 012, it is radially discharged to the outside, and hits the coil 010 inside of the motor or the

generator, and the heat generated by coils are robbed per coil 010.

[0003]

[Problems the present invention attempts to solve]

By the way, regarding the traditional cases, the aforementioned cooling oil was discharged by centrifugal force which accompanies the rotation of the generator or motor, however, the cooling oil amount discharged from the small holes 09 does not become uniform, and the oil amount discharged from the small holes 09b positioned away from the force feeding port 04 became smaller compared with the oil amount discharged from the small holes 09a near from the force feeding port 04, thus causing the non-uniformity of the cooling of coil 010.

[0004]

That reason is that hollow hole 07 is made in parallel with the rotor rotation shaft core 08, the cooling oil 02 which flowed in from the force feeding port 04 aggregated in the small holes 09a near the force feeding port 04, and was discharged, the only small amount of remaining cooling was discharged from the far small holes 09b.

[0005]

Hence, in order to also feed a sufficient amount of oil into the small holes 09b located far from the force feeding port 04, one method can be considered wherein for instance, the supply oil

amount itself of the external hydraulic source 01 can be increased, however, according to this method, it requires another method to increase supply oil amount additionally, and since the oil amount is increased also, oil churning resistance loss inside of the generator or motor is also increased, it is not a gaining measure. However, in the past, this method was used often.

[0006]

As another method to attain aforementioned purpose, the hole diameter of the small hole 09b is made larger than the hole diameter of the small holes 09a, or the hole number of the 09b side is increased more than the hole number of 09a side, thereby, cooling oil amount can be properly distributed, however, making horizontal holes or making many holes in the rotor rotation shaft which transmits the motive force reduces the strength of the rotor rotation shaft, hence, not preferred (however, this method was often used in the past).

[0007]

The purpose of the present invention is to efficiently and uniformly rob the heat generated by the coils inside of the motor or generator over the entire surface of the coil from the load shaft to the counter load side.

[0008]

[Means to solve the problems]

Regarding the forceful hydraulic cooling structure wherein the

inside of rotor rotation shaft is made hollow, into which the cooling oil is force-fed from outside, said cooling oil flies by the centrifugal force,

the cooling structure of the motor or the generator of the present invention is characterized such that the inside of rotor rotation shaft is made hollow, and tapered, and the output side of the motor and the drive side of the generator are made to be the large diameter side of the aforementioned tapered hole.

[0009]

In the traditional examples, the cooling hollow hole of the inside of rotor rotation shaft was processed in parallel with the rotor rotation shaft core, according to the present invention, the force feeding port of cooling oil 04 side was made to have a smaller diameter, load shaft side was made to have the larger diameter, thus creating a tapered hollow hole 7, hence, due to the centrifugal force which acts on the cooling oil, a uniform amount of cooling oil flies into the coil from the small holes of either one of small holes 9a, 9b positions, thus the efficient and uniform coil cooling can be executed.

[0010]

[Embodied form of the present invention]

The following will explain the embodied form of the present invention while referring to the figure 1. Regarding the forcible oil cooling type motor of this invention, the force feeding port

of cooling oil 4 side is made to have a small diameter, and the load shaft side is made to be a tapered hollow hole with a large diameter, hence, due to the impact of the centrifugal force which acts on the cooling oil, hence, due to the centrifugal force which acts on the cooling oil, a uniform amount of cooling oil flies into the coil from the small holes of either one of small holes 9a, 9b positions, thus the efficient and uniform coil cooling can be executed.

[0011]

Figure 1, as previously described, shows the embodied form applied for the permanent magnet type brushless motor of the first embodied form of the present invention. In the following explanation, the state is hypothesized in which the motor is rotating. The cooling oil 2 which was force fed from external hydraulic source 1 flows into the cooling hydraulic port 4 set up at the motor 3. In the vicinity of cooling hydraulic port 4 is set up oil seal 5, thus preventing cooling oil from leaking into the inside of the motor. The cooling oil 2 which flowed in from outside flows into the tapered hollow hole 7 which is made inside of the rotor rotation shaft 6. Regarding aforementioned tapered hollow hole7, the output shaft 12 side is made to be the large diameter hole side of the taper.

[0012]

In the orthogonal direction vis-à-vis the shaft core 8 of the rotor

rotation shaft from hollow hole 7, a plural number of cooling oil spraying small hole 9b, 9a are made with same diameters on the large diameter and small diameter sides respectively. In the state where rotor rotation shaft 6 is in a rotation action, the centrifugal force acts on the cooling oil 2 in the inside perimeter of tapered hollow hole7. This centrifugal force becomes larger than the small hole 9a of the small diameter side in the small hole 9b of the large diameter side, hence, even if the position of the small hole 9b is farther than the small hole 9a, the equal amount of cooling oil flows out form small holes 9b, 9a.

[0013]

As described above, equal amount of cooling oil flows out from small holes 9a, 9b, and flies around and collides with stator coil 10, thus, heat is carried away, thus uniformly cooling the stator coil 10. Next, the cooling oil 2 which cooled stator coil 10 gathers by gravity action in case drain port 11 which is located toward the bottom of the motor, and via oil piping, returns to the external hydraulic source 1 and circulates.

[0014]

Regarding the taper direction when the tapered hollow hole7 is made in rotor rotation shaft 6, as described above, the cooling hydraulic feeding oil port 4 sides, that is, counter output side of the motor is made to be the small diameter side, and the output shaft 12 side of the motor is made to be the large diameter side.

In case tapering processing is done, it is started from the large diameter side and goes to the small diameter side, hence, it is necessary that the output shaft 12 and rotor rotation shaft 6 be made a separate product. Hence, after executing taper processing inside of rotor rotation shaft 6, output shaft 12 and rotor rotation shaft 6 can be joined as a unit by electron beam welding.

[0015]

The above is an applicable example of the present invention for the motor, but in case it is applied to the generator, in the hollow tapered hole of the rotor rotation shaft, if the drive side is made to be the large diameter, the similar cooling method can be adopted.

[0016]

[Effects of the invention]

In the present invention, the structure is adopted wherein the tapered hollow hole is made in rotor rotation shaft, the cooling oil is made to flow thereinto, thereby, the heat generated inside of the motor or generator can be robbed efficiently and uniformly from all over the coil.

[Simple explanation of the diagrams]

Figure 1. It is a cooling mechanism drawing applied for the permanent magnet brushless motor of the present invention

Figure 2. It is a corresponding drawing of the traditional example.

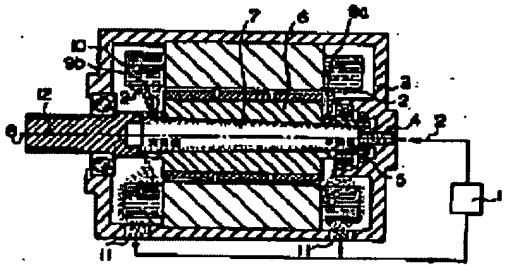
[Explanation of the symbols]

1... external hydraulic source, 2... Cooling oil, 3... A motor, 4... Cooling hydraulic feeding port, 5... Oil seal, 6... Rotor rotation shaft, 7... Tapered hollow hole,

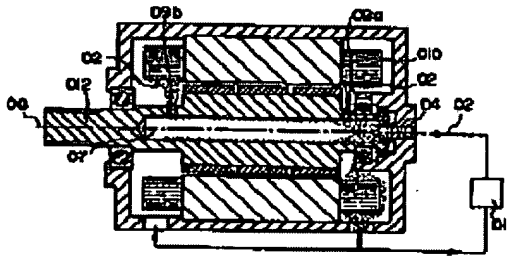
8... rotor rotation shaft core, 9a, 9b... small holes, 10... Stator coil, 11... Case drain port, 12... Output shaft,

01... external hydraulic oil source, 02... Cooling oil, 04... Force feeding port, 07... Hollow hole, 08... Rotation shaft core, 09a, 09b... small holes, 010... Coil, 012... Rotor rotation shaft

【図1】



【図2】



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特開平9－154258

(43)公開日　平成９年(1997)６月10日

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Ｂ６１Ｃ　17/00			Ｂ６１Ｃ　17/00	Ｚ	

審査請求　未請求　請求項の数１　ＦＤ　（全　３　頁）

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(22)出願日　平成７年(1995)11月29日

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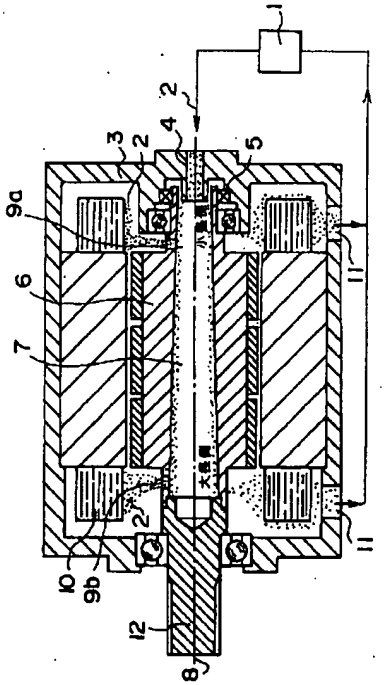
(54)【発明の名称】　強制油冷式電動機又は発電機の冷却構造

(57)【要約】

【課題】　電動機或いは発電機内部のコイルで発生した熱を負荷軸から反負荷軸側に至るコイル全面にわたって効率よく且つ均等にコイル熱を奪い去ることを可能とするにある。

【解決手段】　電動機或いは発電機のロータ回転軸内部の冷却用中空穴は従来回転軸芯に対して平行に加工していたが、本発明では冷却油圧送口４側を小径とし、出力軸側を大径としたテーパ状中空穴としたので、冷却油に作用する遠心力の作用により小穴９ａ、９ｂのいづれからも均等な冷却油がコイルに飛散されることになり、効率のよいコイルの冷却を可能とする。



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【特許請求の範囲】
【請求項１】　ロータ回転軸内部を中空とし、ここに外部から冷却油を圧送して遠心力で該冷却油を飛散させ強制油圧冷却するものにおいて、ロータ回転軸内部を中空でテーパ形状とするとともに、電動機の出力側又は発電機の駆動側をそれぞれ前記テーパ穴の大径側としたことを特徴とする強制油冷式電動機又は発電機の冷却構造。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は電気式駆動車両等に用いる強制油冷方式で高出力化を図った電動機又は発電機のロータ回転軸の冷却油路構造に関する。
【０００２】
【従来の技術】従来の油冷却式発電機或いは電動機においては図２に示す如く、ロータ回転軸０１２に中空穴０７を加工し、このロータ回転軸側面に複数の小穴０９（０９ａ、０９ｂ）を開けて、これら小穴に冷却油を流す穴として用いている。この構造において、冷却油は中空穴０９に圧送された後、複数の小穴０９からロータ回転軸０１２の回転に伴う遠心力により小穴０９から外部に放射状に排出され、発電機或いは電動機内部のコイル０１０に当たり、コイルで発生した熱を奪う構造となっている。
【０００３】
【発明が解決しようとする課題】ところが従来例では、前記冷却油は、発電機或いは電動機の回転に伴う遠心力により排出されるが、小穴０９より排出される冷却油量は均等にはならず、圧送口０４から遠い位置にある小穴０９ｂから排出される油量の方が圧送口０４から近い小穴０９ａから排出される油量に比較して少なくなり、コイル０１０の冷却が不均等を生じていた。
【０００４】これは中空穴０７が回転軸芯０８に対して平行に加工されているために、圧送口０４から流入した冷却油０２が圧送口０４に近い小穴０９ａに集中して排出され、遠い小穴０９ｂからは残った冷却油が少量しか排出されないためであった。
【０００５】従って、圧送口０４から遠い位置にある小穴０９ｂにも十分な油量を供給するには、例えば外部油圧源０１の供給油量自体を増やす方法も考えられるが、この方法では供給油量を増やすための別の方策を更に必要とし、油量も増加するため、発電機或いは電動機内部での油撹拌抵抗ロスをも増加させることとなり、得策ではない。しかし従来は往々にしてこの方法を用いていた。
【０００６】前記目的を達成するための他の手段としては、小穴０９ｂの穴径を小穴０９ａの穴径より大きくするか、又は０９ｂ側の小穴数を０９ａ側の小穴数より多くすることで冷却油量の適正配分を図る方法もあるが、動力を伝えるロータ回転軸に大径の横穴をあけたり、数多くの穴をあけることは、ロータ回転軸の強度を低下させることになり、好ましくない（但し往々にしてこの方法も従来しばしば用いられていた）。

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【０００７】本発明の目的は電動機或いは発電機内部のコイルで発生した熱を負荷軸から反負荷側に至るコイル全面にわたって効率よく且つ均等にコイル熱を奪い去ることである。
【０００８】
【課題を解決するための手段】本発明の発電機或いは電動機の冷却構造は、ロータ回転軸内部を中空とし、ここに外部から冷却油を圧送して強制油圧冷却するものにおいて、ロータ回転軸内部を中空でテーパ形状とするとともに、電動機の出力側又は発電機の駆動側をそれぞれ前記テーパ穴の大径側としたことを特徴としている。
【０００９】従来例ではロータ回転軸内部の冷却用中空穴は回転軸芯に対して平行に加工していたが、本発明では、図１に示すように冷却油圧送口４側を小径とし、負荷軸側を大径としたテーパ状中空穴７としたので、冷却油に作用する遠心力の作用により、小穴９ａ、９ｂのいづれの位置にある小穴からも均等な冷却油がコイルへ飛散されることとなり、効率よく均等にコイルの冷却を行うことが可能となる。
【００１０】
【発明の実施の形態】以下図１を参照し本発明の実施の形態について説明する。本発明の強制油冷式電動機冷却油圧送口４側を小径とし、負荷軸側を大径のテーパ状中空穴としたので、冷却油に作用する遠心力の影響でいづれの位置にある小穴９ａ、９ｂからも均等な冷却油がコイルへ飛散され、効率のよいコイル冷却が可能となるようにしたものである。
【００１１】図１は前述のとおり本発明に係る第１実施例の永久磁石式ブラシレス電動機に適用した実施例を示す。以下の説明においては、電動機が回転作動している状態を想定することにする。外部油圧源１から圧送された冷却油２は電動機３に設けられた冷却油圧送口４に流入する。圧送口４付近にはオイルシール５が配設され、冷却油が電動機内部に漏れることを防止している。外部から流入した冷却油２はロータ回転軸６内部に加工されたテーパ状中空穴７に流入する。前記テーパ状中空穴７は出力軸１２側がテーパの大径穴側となっている。
【００１２】中空穴７よりロータ回転軸の軸芯８に対して直角方向に複数の冷却油噴霧用小穴９ｂ、９ａが大径及び小径側にそれぞれ同径として加工されている。ロータ回転軸６が回転作動している状態では、テーパ状中空穴７内周の冷却油２には遠心力が作用する。この遠心力は大径側の小穴９ｂでは小径側の小穴９ａより大きくなるため、小穴９ｂの位置が小穴９ａより遠距離であっても小穴９ｂ、９ａから等量の冷却油が流出する。
【００１３】以上のようにして小穴９ａ、９ｂから等量の冷却油が流出しステータコイル１０に飛散衝突して熱を持ち去り、ステータコイル１０を均等に冷却すること

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ができるようになる。次いでステータコイル１０を冷却した冷却油２は重力の作用により電動機の下方にあるケースドレン口１１に集まり油配管を経由し、外部油圧源１に再び戻り循環する。

【００１４】ロータ回転軸６にテーパ状中空穴７を加工する際のテーパの向きは、上述したように、冷却油圧送口４側即ち電動機の反出力側を小径側とし、電動機の出力軸１２側を大径側としている。テーパ加工を行う場合は、大径側からはじめ小径側に至るため、出力軸１２とロータ回転軸６を別部品とする必要を生じる。従ってロータ回転軸６内部にテーパ加工を施した後、出力軸１２とロータ回転軸６を例えば電子ビーム溶接で一体結合すればよい。

【００１５】以上は電動機に対して本発明の適用例であるが、発電機に適用する場合にもロータ回転軸の中空テーパ穴において駆動側を大径とすれば、同様の冷却手段が採用可能である。

【００１６】

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【発明の効果】本発明においてはロータ回転軸にテーパ状中空穴を加工し、ここに冷却油を流し込む構造を採用することにより、電動機或いは発電機内部のコイルで発生した熱を、ステータのコイル全面にわたって効率よく且つ均等に奪い去ることができる。

【図面の簡単な説明】

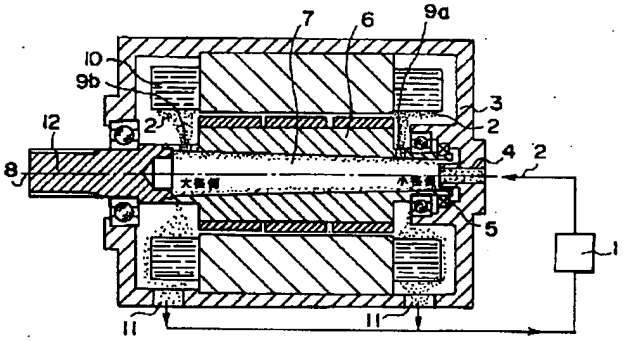
【図１】本発明の第１実施例に係わる永久磁石式ブラシレス電動機に適用した冷却構造図。

【図２】従来例の図１応当図である。

【符号の説明】

１…外部油圧源、２…冷却油、３…電動機、４…冷却油圧送口、５…オイルシール、６…ロータ回転軸、７…テーパ状中空穴、８…ロータ回転軸芯、９ａ、９ｂ…小穴、１０…ステータコイル、１１…ケースドレン口、１２…出力軸、０１…外部油圧源、０２…冷却油、０４…圧送口、０７…中空穴、０８…回転軸芯、０９ａ、０９ｂ…小穴、０１０…コイル、０１２…ロータ回転軸。

【図１】



【図２】